Plug and Play: Utilizing MOFs in Preexisting Carbon Dioxide Removal Assemblies for Enhanced Performance, Smaller Footprint, and Lower Energy Consumption., Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

Protection against the buildup of CO_2 in spacecraft is of crucial importance to astronaut health. Currently, several methods are used to remove CO_2 from spacecraft including amine scrubbers, lithium hydroxide canisters, and adsorbent-based carbon dioxide removal assemblies (CDRAs). Each scrubbing method has individual benefits and drawbacks: amine scrubbers have no particulate release but require high-energy regeneration; lithium hydroxide offers high capacity but the canisters are non-regenerable; and CDRAs offer moderate regeneration but suffer from dusting. The ideal unit would afford high CO_2 capacity, low regeneration costs, minimized footprint and weight, and minimal particulate release.

CDRAs, the preferred technology of NASA, currently utilize beds of Zeolite 5A and Zeolite 13x to remove CO_2 and H_2O, respectively. The drawbacks of this system are a result of the zeolite. Zeolites are a restrictive class of materials, where the inability to tune the material prevents further improvements in the CDRA system. Furthermore, utilizing zeolites in different environments beyond the CDRA system may further highlight the weakness of these materials for CO_2 management.

In contrast to zeolites, metal-organic frameworks (MOFs) are a diverse class of chemically tunable adsorbents. NuMat Technologies (NuMat) proposes displacing zeolites in CDRA systems with MOFs, enhancing the properties of these systems. The ability to displace the water and carbon dioxide zeolites with a MOF will be evaluated. In addition, the ability of MOFs to be employed in other CO_2 management environments will be investigated. During Phase I, NuMat will develop an understanding of how MOFs can enhance existing systems by utilizing the components of the system and simply replacing the zeolite bed with MOFs. This protocol of utilizing existing engineered systems will allow for MOFs to be rapidly transitioned through later technology readiness levels.

Anticipated Benefits

This phase one application will allow NuMat Technologies to understand how a new class of adsorbents, metal-organic frameworks (MOFs), can be employed in CO_2 management systems. This has the potential to be employed in multiple NASA applications. Primarily, these materials will be used to upgrade existing CDRA systems offering enhanced performance. Secondly, these materials have the potential to be employed in other CO_2 management systems for use in surface systems and EVA systems.

The work under this grant has the potential to be used in a wide range of Non-NASA applications. CO_2 control is important in other confined environments including rebreather applications and onboard submarines. With mounting

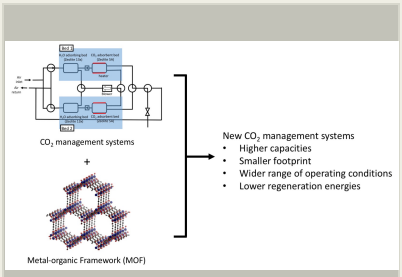

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Table of Contents

Plug and Play: Utilizing MOFs in Preexisting Carbon Dioxide Removal Assemblies for Enhanced Performance, Smaller Footprint, and Lower Energy Consumption., Phase I

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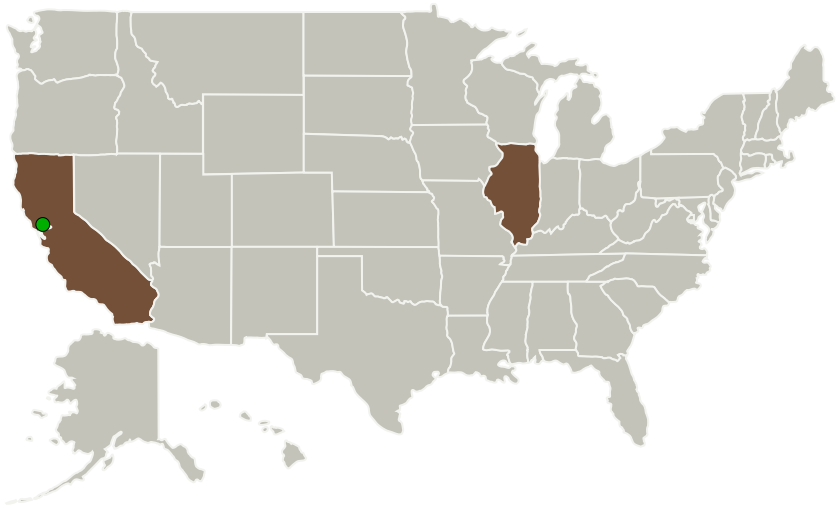
concerns about the environment, these materials have the potential to be scaled further and used in H_2O harvesting and CO_2 sequestration applications. NuMat Technologies is dedicated to investigating these applications as we seek to utilize MOFs in commercial applications.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
NuMat Technologies	Lead Organization	Industry Minority-Owned Business	Skokie, Illinois
Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California
Northwestern University	Supporting Organization	Academia	Evanston, Illinois

Primary U.S. Work Locations	
California	Illinois

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

NuMat Technologies

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

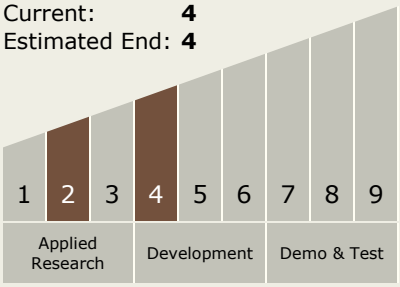
Carlos Torrez

Principal Investigator:

William Morris

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



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Project Transitions

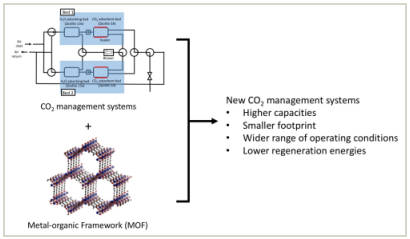
July 2018: Project Start

August 2019: Closed out

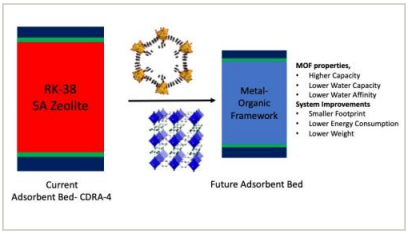
Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137880)*

Images



Briefing Chart Image
Plug and Play: Utilizing MOFs in Preexisting Carbon Dioxide Removal Assemblies for Enhanced Performance, Smaller Footprint, and Lower Energy Consumption., Phase I
(https://techport.nasa.gov/image/126474)



Final Summary Chart Image
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(https://techport.nasa.gov/image/128944)

Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.1 Environmental Control & Life Support Systems (ECLSS) and Habitation Systems
    - TX06.1.1 Atmosphere Revitalization

Target Destinations

Earth, The Moon, Mars